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(54) PREPARATION OF PRINTING PLATES BY JOINING EDGES OF PHOTOHARDENABLE LAYERS

(71) We, E. I. DU PONT DE NEMOURS AND COMPANY, a Corporation organised and existing under the laws of the State of Delaware, located at Wilmington, State of Delaware, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:–

This invention relates, generally, to flexographic printing and, more particularly, to the provision of nonprinting joints at the meeting edges of light-hardenable thermoplastic elastomeric printing plates.

Light-hardenable elastomeric printing plates include a support, preferably a polyester film, and a light sensitive layer which contains a synthetic elastomer binder, a photopolymerizable compound or a photocrosslinkable composition and a photoinitiator system. The light sensitive layer is soluble in an appropriate solvent or wash-out solution. Upon exposure to radiation, usually ultraviolet radiation, the exposed areas become insoluble in the solvent while the unexposed areas retain their original solubility. When such a printing plate is exposed imagewise through a suitable transparency and then processed in a wash-out solution comprising a solvent, a relief image is obtained corresponding to the imagewise exposure. The exposed and processed plate is particularly useful in flexographic printing.

It has been the practice to mount the plate on a printing cylinder, usually by securing it to the surface of the cylinder with two-sided adhesive tape. Considerable difficulties are encountered in the printing of continuous images, because it has not been possible to connect the ends of the printing plate lying on the printing cylinder in a way that the line of joinder is not visible in the printed picture. Additionally, the printing ink penetrates through the joint and dissolves the adhesive, leading to considerable difficulties during the printing process.

It is known in the art to connect the edges of thermoplastic strips or tapes by trimming and contacting the edges and then heating them close to the melting point of the thermoplastic material. While in this soft state, the thermoplastic material is pressed together (see USP 2,379,500 to Steffens). However, when that sequence of steps is used to join edges of a light-hardenable printing plate and the joint falls within the effective printing area of the plate, the results are unsatisfactory because of a seam which is visible in and interrupts the printed image. This is so because the heated thermoplastic material tends to bulge and protrude to printing height during the abutment and pressing of the edges to be connected. Even the use of fillers to join the edges of plastic plates, as is often done, is not satisfactory, as the seam formed is still visible in the print.

This invention provides a process for the physical joinder of light-hardenable thermoplastic elastomeric printing plates, wherein the photochemical and physical characteristics of the photohardenable material remain essentially unchanged in the vicinity of the joint.

According to the invention there is provided a process for joining edges of printing plates comprising a support film and a photohardenable thermoplastic elastomeric layer wherein, before imagewise exposure and development to form a printing relief, the edges to be joined are trimmed so as to abut and are held butted together while at least the plate areas adjacent the edges to be joined are exposed over a previously set time period to elevated temperature and elevated pressure until a welding of the butting edges of said layer has occurred, thereby forming a joint having a smooth surface in a plate of uniform thickness, the welding temperature being between the glass transition and the

melting temperatures of the photohardenable layer. The process of this invention is simple and easy to carry out. While the effect of high temperatures can lead to undesirable polymerization and/or crosslinking in light-hardenable layers, it has been found, surprisingly, that the high temperature used in the process of the invention does not adversely affect the photosensitive characteristics of the light sensitive layer. Moreover, it has been found, surprisingly, that the temperature treatment has a beneficial effect on the sensitivity of the printing plates. The welding temperature should be sufficiently high that welding is completed in a reasonable time. In a preferred embodiment of the invention, the welding temperature is 100 to 120°C and the pressure exerted on the butted edges is from 0.02 to 0.01 kilograms per square centimeter (kg/cm^2). The duration of the welding process can be from 20 to 120 minutes.

Under these conditions, the butted edges of the photohardenable layer combine to form a homogeneous joint of high mechanical strength which does not produce a visible mark in printing and whose photosensitive characteristics do not differ from those of the remainder of the plate. In a preferred embodiment, the backsides of the plates to be joined are secured on a dimensionally stable base using, for instance, two-sided adhesive tape. When joining is accomplished in this way, it can be carried out effectively and the results are of high quality.

In practice, the process of the invention may be accomplished in a number of ways. For instance, the plate sections near the butted edges may be pressed between heated solid elements. Preferably, the nonprinting connection is obtained through calendering of the plate at elevated temperatures.

When the calendering process is used, it is possible to obtain a nonprinting joinder of the ends of a plate directly on the printing cylinder or, if so desired, on a removable mounting sleeve that can be fitted over the printing cylinder. In order to accomplish this, the process is carried out using a printing plate provided on the backside with a thin support film such as polyester film base. The edges to be joined, in this case the plate ends, are trimmed carefully so that, when the plate is wrapped around the cylinder, they abut. The plate is placed over the surface of a rotatably mounted printing cylinder or a removable mounting sleeve which is adapted to fit over the main printing cylinder and, using two-sided adhesive tape in the vicinity of the juncture, the plate is held on this surface. The cylinder or sleeve with the plate mounted thereon is rotated in contact with at least one heated calender roll until a welding of the light-hardenable material is accomplished at the line of juncture.

The calendering process ensures the uniform covering of the printing cylinder or sleeve by the light-hardenable plate. When this process is used, the connection is smooth and does not appear in print so that such cylinder or sleeve is especially well suited for printing of continuous patterns on wallpaper and similar articles.

Continuous cylindrical plates mounted on printing cylinders can also be produced and calendered in variations of the aforementioned process. It is possible, for example, to generate the calendering pressure by a yielding preferably springlike pressing of the heated roll to the peripheral surface of the cylinder or the sleeve carrying the printing plate. It is also possible to use the weight of the printing cylinder to provide the required pressure. In that case, the printing cylinder covered with the printing plate is permitted to turn on a heated roller rotating about a horizontal axis using, if necessary, additional guide rollers or other means to maintain the plate in the correct position. By properly controlling the pressure and position of the roller as it turns, one can ensure that the thickness of the light-hardenable plate mounted on the printing cylinder is accurately controlled to the desired combined cylinder plus plate diameter.

Similarly, when using a press mounting sleeve, that is a removable cylinder which fits over a demountable core on the press, one may first attach the printing plate on the mounting sleeve prior to subjecting it to heat and pressure to generate a nonprinting seam. During this process, the plate and mounting sleeve may be rotated over a roller using guiding devices which may comprise additional rollers to hold it in place. In order to obtain a calendering effect, weights are inserted in the printing sleeve to achieve the desired pressure. The end result of this process is a printing plate-mounting cylinder combination of a highly accurate cylindrical form. This is a highly desirable result since, in practice, press mounting sleeves are not true cylinders but have a slightly conical shape to facilitate insertion and removal of the sleeve shaped printing plate.

It is also possible, using the process described, to join smaller plates to form plates of greater dimensions. To this effect, in another embodiment of the present process, the plate areas adjoining the butted edges are pressed between solid heated elements for welding without the addition of excess materials. It may on occasion be advantageous to place between the solid heated molding or welding elements and the light-hardenable layer, an intermediate covering film of plastic which may preferably be a polyester film. Additionally, one may use a plate somewhat larger than the desired final plate format in one dimension, to provide excess material along the two edges that are

not to be connected. This excess material can be exposed to ultraviolet (UV) radiation to provide a hardened edge, beyond the image area, which is later trimmed prior to using the joined plate. This hardened edge prevents the flowing of the printing plate during the application of heat and pressure.

According to the described process, light-hardenable thermoplastic elastomeric printing plates may be connected to form a homogeneous joint of high mechanical strength which is smooth and does not print. Moreover, penetration of the printing ink has been reliably prevented. There is thus afforded an opportunity to the practitioner of the flexographic art to cover printing cylinders with light-hardenable printing plates without seams in the image area. These plates can be particularly useful in continuous rotary printing according to the most varied printing processes. It can be used, for example, for relief printing as well as for intaglio and lithographic printing.

Several embodiments of the invention are illustrated by the following figures where:

Figure 1 shows a greatly enlarged cross section through a light-hardenable printing plate;

Figure 2 is a schematic representation showing the placement of the adjacent edge sections of two printing plates to be connected;

Figure 3 is a schematic representation of an arrangement for joining the two plate edges shown in Fig. 2.

Figure 4 is a schematic representation of the preparation of a cylindrical printing plate using a light-hardenable printing plate;

Figures 5 and 6 are front and side views showing a schematic arrangement for the preparation and calendering of a printing cylinder covered with a light-hardenable printing plate;

Figures 7 and 8 are perspective and end views showing a schematic arrangement of a variation of the process for preparing and calendering a printing cylinder or press mounting sleeve covered with a light-hardenable printing plate.

As indicated in Fig. 1, a flexographic printing plate 1 on which the process of this invention may be applied has a thin support 2 comprised of polyester film base.

Onto this film support 2 there is applied a layer 3 of light-hardenable material. On the upper surface, layer 3 is covered with a protective film 4 made of polyester, and more particularly, a polyester of ethylene glycol and terephthalic acid which protects the surface against outside influences. This covering film 4 is removed prior to exposure and processing of the plate 1.

In the instant process, a printing plate is first exposed to UV radiation, through the support film 2, in a vacuum frame for a period of time sufficient to harden the light-hardenable material to a point approximately half-way between film support 2 and covering film 4. Following this back exposure, the plate is removed from the exposure unit and joined according to one of the processes described below.

Figures 2 and 3 show an embodiment of the process of this invention for fusing together adjoining edges of light-hardenable plates 1. For this purpose, the two plates 1 to be joined are first trimmed to produce a butting fit along the joint 5 and brought together. A two-sided tape strip 6 is glued across the edges which have been brought together, which tape has its free side glued to a heated support with high heat conductivity such as an aluminium plate 7. Covering films 4 of printing plates 1 are removed and replaced by covering film 4*a* (Fig. 3) extending over the joint 5. Over this covering film 4*a*, there is placed a heated plate 8 also having good heat conductivity such as a second aluminium plate.

By means of the two aluminium plates 7 and 8, the inserted parts of the printing plates 1 are heated to a temperature of 100°C and a pressure of approximately 0.025 kg/cm² is applied preferably through plate 8. These conditions are maintained for 60 minutes. During this treatment, the light-hardenable material of layers 3 of plates 1 is fused together without generating a bulge, thereby forming a smooth, uniform layer. In spite of the thermal pressure treatment, the photopolymer remains completely photosensitive. No detectable bulge results along support film 2. The welding of the light-hardenable layers 3 yields sufficiently strong connections.

Then, the protective film 4*a* is removed from the upper surface and an image bearing high contrast half tone negative of the type commonly used in the printing industry is placed in contact with the upper surface of the flexographic printing plate. The combination is placed in a vacuum frame with the negative facing a source of ultraviolet radiation. Vacuum is applied to assure good contact between the plate surface and the negative, and the plate is exposed the required amount of time.

The plate is next removed from the exposure unit, and the negative removed from contact with the plate surface. The plate is then mounted on the cylinder of a developing apparatus designed for the removal of unexposed photohardenable material through the application of a solvent solution and brush scrubbing. Next, the plate is post treated with a chemical solution to produce a substantially nontacky surface. Following drying through the application of heat, the plate is mounted on a printing cylinder for use.

In Fig. 4, the same type of arrangement

illustrated in Figs. 2 and 3 is used for fusing together the ends of a flexographic printing plate. A printing plate 1 is trimmed along two end edges and then formed into a tubular sleeve. On the inside of the sleeve formed by printing plate 1, there is placed a first curved plate 11 to increase the applied pressure. The two butting edges of printing plate 1 are again secured by means of a two-sided adhesive tape 6 to the curved metal plate 11. Over the outside of the joint 5, there is placed a covering film 4*a* of a polyester material. Outside of this covering film there is placed a second curved metal plate 12. Heat is supplied to this metal plate to raise the temperature of the areas of the plate 1 located between metal plates 11 and 12 to approximately 100°C. The two metal plates 11 and 12 apply a pressure of .05 kg/cm². This treatment is carried out for a time period of 30 min.

In practice, it is sometimes difficult to fit a flexographic printing plate sleeve of the type shown in Fig. 4 over a printing cylinder. Figs. 5 and 6 show a preferred embodiment which allows instead for covering a printing cylinder or press mounting sleeve with a printing plate prior to the fusion of the two ends. More particularly, Fig. 5 shows a fusing and calendering arrangement which can be used to place an accurately trimmed printing plate 1 over a printing cylinder 21 and to fuse the edges together to provide a continuous plate. By the accurate trimming of plate 1, the edges to be joined present a butting joint 5. Below this butting joint, the film support is fastened by means of a two-sided adhesive tape onto the printing cylinder 21. Next, the printing cylinder covered by the printing plate is placed onto a rotatable support. Onto the printing plate 1 forming a cover for printing cylinder 21 is then placed a heating roller 22 which is pressed on by a calendering pressure P. Heating roller 22 is then heated to a temperature of approximately 100 to 120°C. Both cylinders 21 and roll 22 are put in motion. The fusing and calendering process so initiated is then carried out for a time period of 30-60 minutes.

During this fusing and calendering process, the two trimmed edges of printing plate 1 placed on the printing cylinder 21 fuse together to create a nonprinting connection. Excess material is then actually squeezed off to the outside. This yields a uniform smooth homogeneous joint. Depending on the pressure applied to heating roller 22, a true calendering action is exerted so that a light-hardenable sleeve with decreased but uniform thickness is obtained. Tests have shown that material thickness can be made uniformly accurate to ± .02 mm.

Figs. 7 and 8 illustrate a variation of the preferred embodiment where the rotating cylinder is covered over its surface in the above described manner with a printing plate in such a way that the trimmed edges of the printing plate 1 produce a butting joint 5. To fasten the printing plate to the printing cylinder 21, a two-sided adhesive tape 6 is applied between printing plate 1 and the surface of cylinder 21. The printing cylinder 21 so prepared, is placed onto parallel rollers 23 and 24, of which one roller at least, such as roller 23, is heated. One or both of the rollers 23 and 24 can be rotatably driven. Roller 24 may serve as a support roller. The calendering pressure required for the treatment of the printing plate and the fusing of the butting edges in this embodiment is produced by the inherent weight of the rotating printing cylinder. Roller 23 is heated to a temperature of 100 to 123°C. The duration of the treatment may vary between 30 to 90 minutes.

In the embodiments of Figs. 5-8, it is possible to cover a removable sleeve with the photohardenable printing plate instead of the rotating printing cylinder. This sleeve can then be inserted over the printing cylinder using an arrangement in which a layer of air acts as a lubricant to allow this plate-bearing sleeve to slide over the cylinder. In the embodiment of Fig. 5, the sleeve would only have to be fitted with two face sides carrying pivot pins (instead of a traversing axle) to be able to relocate the sleeves exactly. In the embodiment of Fig. 7, when a mounting sleeve is used rather than a printing cylinder, weights may have to be introduced into the sleeve to generate the necessary calendering pressure.

Plates joined according to the processes of Figs. 4-8 are exposed in the round, i.e. a negative is placed over the outer surface and exposed while in this cylindrical form. The remainder of the process is the same as has been described above in connection with the embodiment of Fig. 4.

WHAT WE CLAIM IS:

1. A process for joining edges of printing plates comprising a support film and a photohardenable thermoplastic elastomeric layer, wherein, before imagewise exposure and development to form a printing relief, the edges to be joined are trimmed so as to abut and are held butted together while at least the plate areas adjacent the edges to be joined are exposed over a previously set time period to elevated temperature and elevated pressure until a welding of the butting edges of said layer has occurred, thereby forming a joint having a smooth surface in a plate of uniform thickness, the welding temperature being between the glass transition and the melting temperatures of the photohardenable layer.

2. A process according to claim 1 wherein the welding temperature is maintained at 100 to 120°C and the pressure

exerted onto the plate area adjacent the butted edges is from 0.02 to 0.1 kg/cm^2 for 20 to 120 minutes.

3. A process according to claim 1 or 2 wherein before welding the plate areas adjacent the butted edges are adhered to each other and against a dimensionally stable support.

4. A process according to any one of claims 1 to 3 wherein the plate areas adjacent the butted edges are subjected to a multiple calendering effect under elevated temperatures with a calendering device lying essentially at right angles to the butted edges.

5. A process according to claim 4 for preparing a rotatable printing cylinder covered with a light-hardenable printing plate wherein, before pictorial exposure, a light-hardenable printing plate covered on the backside with a thin support film of plastic is trimmed along its ends to a length equal to the circumference of the printing cylinder to be prepared, the trimmed plate is placed over the peripheral surface of a rotatable printing cylinder or a sleeve to be slipped onto the printing cylinder and is adhered at least in the area of the butting trimmed ends by means of a two-sided adhesive tape, and the cylinder or sleeve so covered is revolved under pressure in contact with at least one heated calender roller until a welding of the butting trimmed ends has occurred.

6. A process according to claim 1 substantially as described with reference to any one of Figures 3 to 8 of the accompanying drawings.

7. A printing plate having a join therein formed by a process as claimed in any one of the preceding claims.

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1579817 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

FIG. 1

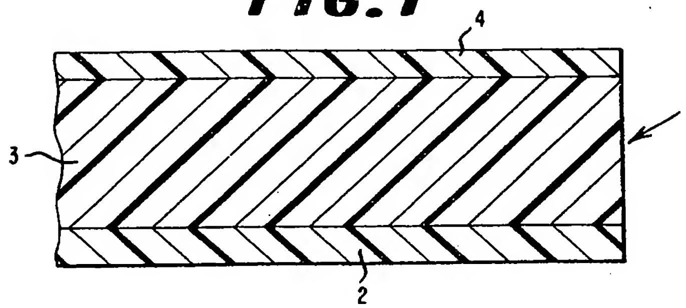


FIG. 2

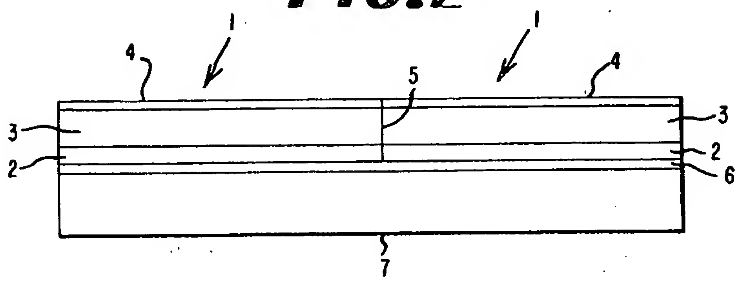
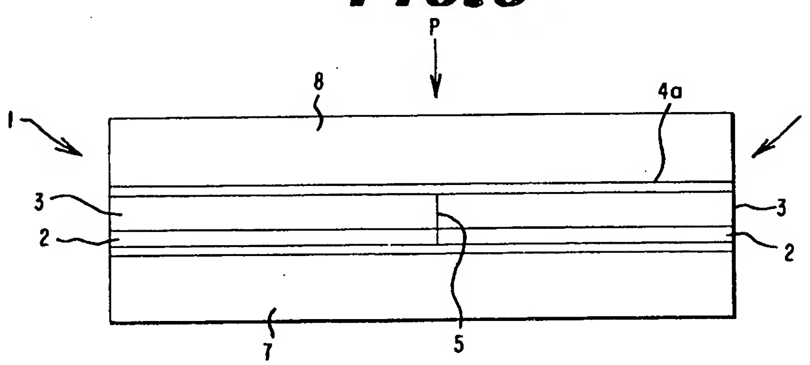


FIG. 3



1579817 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 2

FIG.4

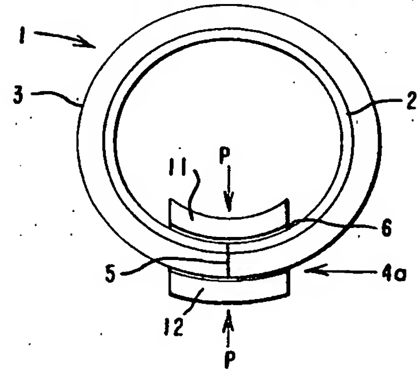


FIG.5

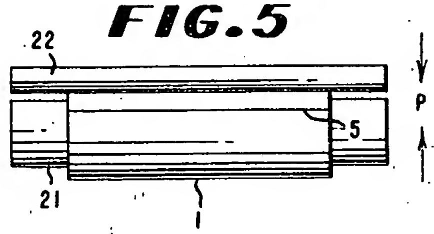


FIG.6

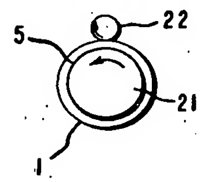


FIG.7

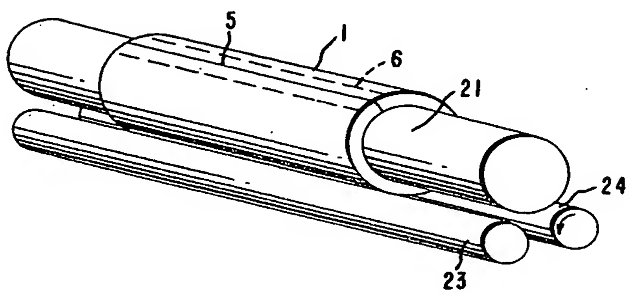


FIG.8